OBSERVE CHANGING ON ELECTRODE MASS DURING USING FAST CHARGING METHOD

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Abstract

In this time is not unambiguously evidenced if the fast charge on Ni-MH batteries gives betterment on structure of electrodes and prolongation of battery's life. The destination of this work is to demonstrate the effect of standard and fast charge on Ni-MH batteries in practise.

Introduction

In this time the rechargeable batteries represent main restrictive factor for expressive use of electric vehicles, mainly for their short range and high acquisition price. Their extension range is restricted firstly by using a new type of batteries as nickel and hybrid metal, Li-ion and zinc-air or zinc-silver. Second by using systems of fast charging that demeans time of charging from 6 and more hours to 2 hours and less.
Type of acumulators for using in electric vehicles
On the beginning of project I decided to use commercial Ni-MH accumulators from company SAFT, serie VH (Figure No. 1), attribution of single accumulator is VH D. This type of accumulator is normal accessible on European market and it is determinated for using in electric scooter, electric bicycle and wheelchair for handicapped people. Of course it has other using in a lot of mobile electrical equipment. Let say some of his pre-eminence: relative big capacity, possibility of fast and ultrafast charging, temperature range from 0 to 40 °C, good possibility of storing and so on.

Electrical properties, dimensions and weight of cell

Rated voltage	1.2 V
Typical capacity	8500 mAh
Minimum capacity	8000 mAh
IEC designation	HR 33/62
Impedance by 1 kHz	4 mΩ
Standard charging current	850 mA
Charging time	16 h
Permanent discharging current at 20 °C	40 A
Peak discharging current at 20 °C	100 A
Temperature range	0 - 40 °C
Weight	160 g

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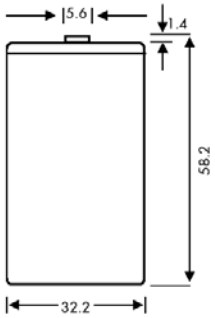

Fig. 1 *Scheme of the cell (dimensions in mm)*

The first using batteries and capacity test

For good functionality introduction accumulator cells to using its necessary to do formatted. Most of available cells are formatted by producer in advance. And Ni-MH accumulator from company SAFT type VH D is formatted by producer. It follows that before the pre-production and following by measuring in practise is necessary do capacity test. Capacity test was done by the norm ČSN EN 61951-2. Capacity test is done as follows. The first I had to discharge the single cell to definitive voltage 1 V. After charging it was necessary to wait for 1 to 4 hours and then I had to do discharging 0.2 I_t for time 5 hours. Capacity test was done at 25 cells. Every cells was designation by the number.

The work place for doing capacity test

The work place is showed on the Figure 2. There are chargers and dischargers controlled by the computer with optimal software. Communication between computer and charges is running on the serial data communication. Chargers are transferring data to the computer. Data contains values of temperature on the cells, current and voltage. Measure single quantity run in period of 15 seconds.

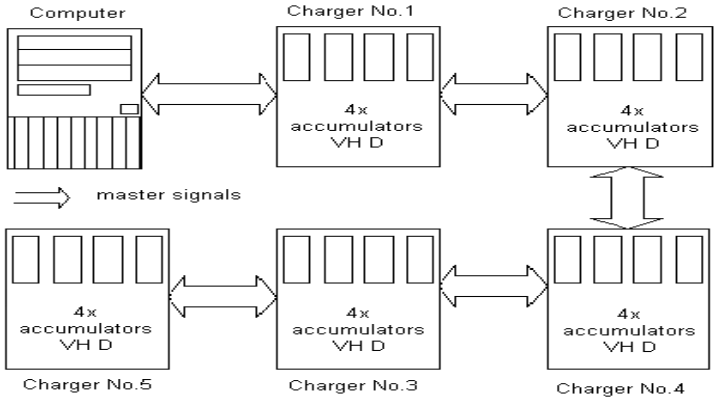

Fig. 2 *Block diagram – work place for capacity test*

Capacity of single cells in the begining of using

The cells are delivered by the producer they should have manufacture capacity. Capacity of single cell never be the same but capacity should not be down under specific stint.

Production procedures are not able to reach corresponding capacity at all cells. Capacity was calculated by the software, which was delivered to chargers. Measured value of capacity after zeroth charging cycle single cells I show in the Table 1.

Capacity of single cells in operation

During a few first cycles the capacity of the cells are increased and settled on average value 9.3 Ah. By right observance specification for working cells the capacity stay approximately on 1400 cycles. Then the capacity begin quite quickly dropped.

Table 1 *Comparison measured value of capacity after 0 and after 50 charging cycle*

Number of Cells	Capacity [Ah] after 0 cycles	Capacity [Ah] after 50 cycles	Number of Cells	Capacity [Ah] after 0 cycles	Capacity [Ah] after 50 cycles
1	7.875	9.213	14	8.182	9.572
2	7.700	9.410	15	7.956	9.521
3	7.877	9.299	16	7.926	9.308
4	8.065	9.436	17	7.919	9.231
5	8.027	9.397	18	7.855	8.917
6	8.196	9.411	19	7.862	8.939
7	8.230	9.537	20	7.670	9.023
8	8.007	8.999	21	8.213	9.563
9	7.798	8.944	22	8.051	9.419
10	8.109	9.412	23	7.928	9.253
11	7.559	8.947	24	8.022	9.381
12	8.211	9.600	25	8.134	9.217
13	7.762	9.103			

Difference between Ni-CD and Ni-MH batteries

At present building satellite towns and new suburban towns are increasing, which are impacting ecology and deterioration of environmentally through increasing traffic load. This problem is possible to solve implementing “clear“ traffic. As “clear“ traffic are using electric vehicles. In this situation is need increase driving range of electric vehicles and shorten time of charging. By comparing price of NiCd and NiMH batteries are competent for using fast charging. These methods are in shorting time of charging and longing lifetime of batteries in electric vehicles.

Table 2 *Specific energy and service life of accumulator batteries used in electric holding ROBOTIC*

Type battery	Lead - acid	Ni - Cd	Ni - MH	Li - ion	Zn - air
$Wh.kg^{-1}$	35	42	65	115	180
number of cycles	400	1400	1500	800	400

Table 3 *Technical parameters of lead-acid, Ni-Cd and Ni-MH batteries used in electric holding scooter ROBOTIC*

Parameter	Ni-Cd VR7F (20 ks)	Ni-MH VH D 8500 (20 ks)
Voltage (V)	24	24
Nominal capacity (Ah)	7.0	8.5
Typoval capacity (Ah)	7.5	9.3
Service life (cycles)	1400	1500
Weight (kg)	5.1	3.2
Price (CZK including VAT)	8784	8784

Microscopy enquiry

I unjointed the lowest cell number eleven (11). Before unjointing I had to discharge the cell on 0.3 V, not to take place short circuit and change structure of electrode. After removal metallic case of battery is necessary separate positive and negative electrodes from separator. Every electrode I cut to 30 square with dimensions 1.5 x 1.5 cm. By doing sample we must be carefully to not touch the sample. After cutting is necessary to clean sample from electrolyte. The electrolyte is cleared by dipping into distilled water for 24 hours. This procedure we must repeat twice. After this we must dry the sample, it takes about 12 hours. Then we put the sample to the PVC pocket and herewith we hinder from solvent environment on sample.

Conclusion

In the present time Ni-MH cells, which are using as power source in electric vehicles, have lifetime about 1000 cycles. After making basic measurement and after few cycles is not indemonstrable difference between standard and fast charging.
Not even microscopy observation structures of electrodes did certify difference between standard and fast charging. But I suppose that differences will be show with excrescent number of cycles.

References

1. ČSN EN 60 285+A1 (36 4370) Alkalické akumulátorové články a baterie-Niklkadmiové válcové neprodyšně uzavřené akumulátorové články. Praha, Český normalizační institut, 1996.
2. ČSN EN 61 436 (36 4377) Akumulátorové články a baterie obsahující alkalické nebo jiné nekyselé elektrolyty-Niklmetalhydridové uzavřené plynotěsné akumulátorové články. Praha, Český normalizační institut, 1999.
3. ČSN EN 61 434 (36 4390) Akumulátorové články a baterie obsahující alkalický nebo jiný nekyselý-Pokyny pro značení proudu v normách pro alkalické akumulátorové články a baterie. Praha, Český normalizační institut, 1998.
4. Saft, Romainville, France, Portable Ni-Cd and Ni-MH cells and batteries catalogue, 1999.
5. Panasonic Industrial Europe GmbH, Hamburg, Germany, Nickel Cadmium Batteries Technical Handbook ‘98/’99, 1998.